# Use of OMI Tropospheric Ozone Products for Air Quality Studies

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# Maximize Information from OMI Total Ozone Data To Generate Tropospheric Ozone Product

**Challenge: Separate Stratosphere Column Ozone from Total Ozone Signal**

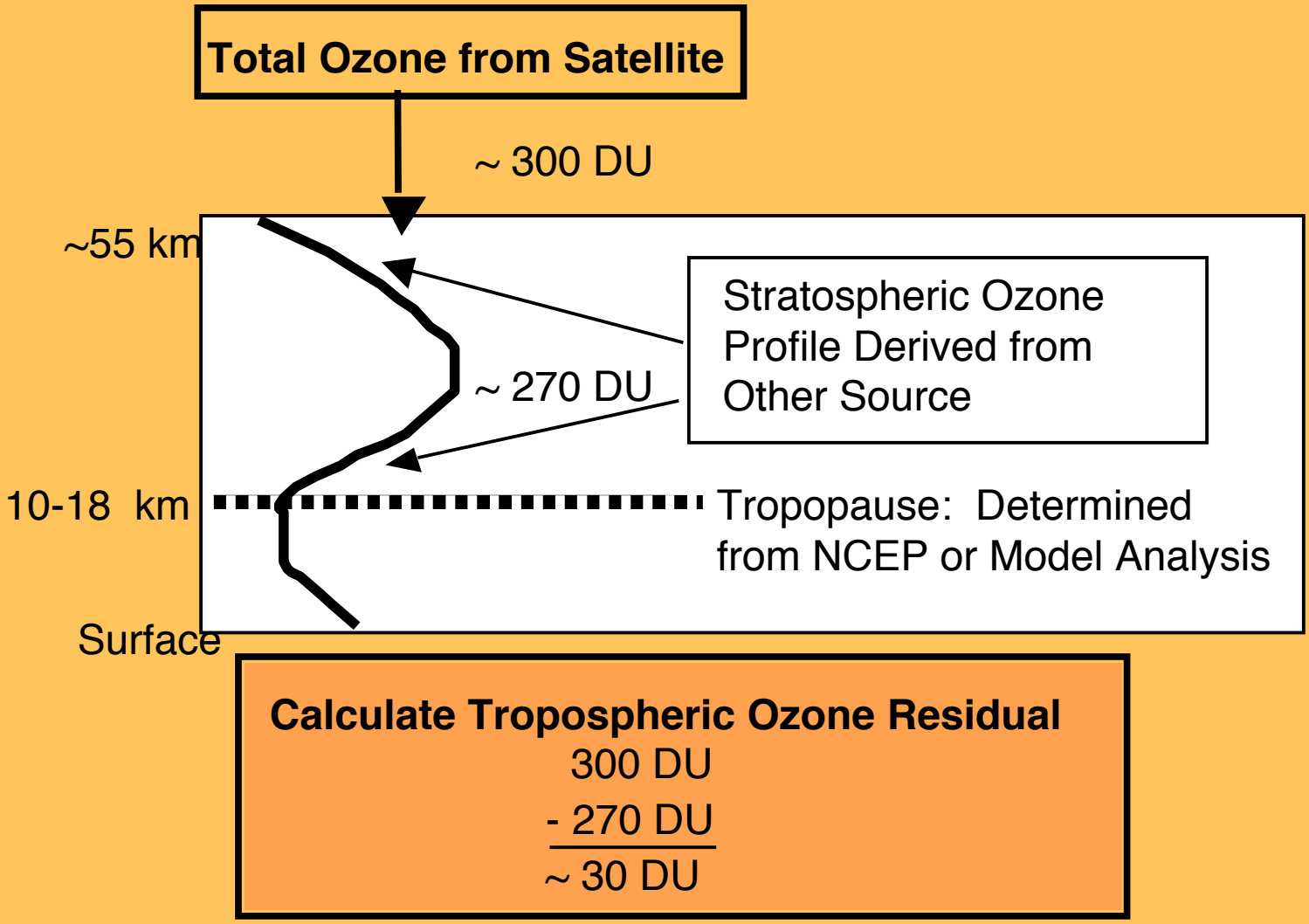
TOMS Heritage:

- Collocated SAGE Ozone Profiles
- SCO Field Generated from SBUV Ozone
- Convective Cloud Differential
- Scan-angle Dependence
- Adjacent Altitude Differential
- SCO from MLS

Current Study:

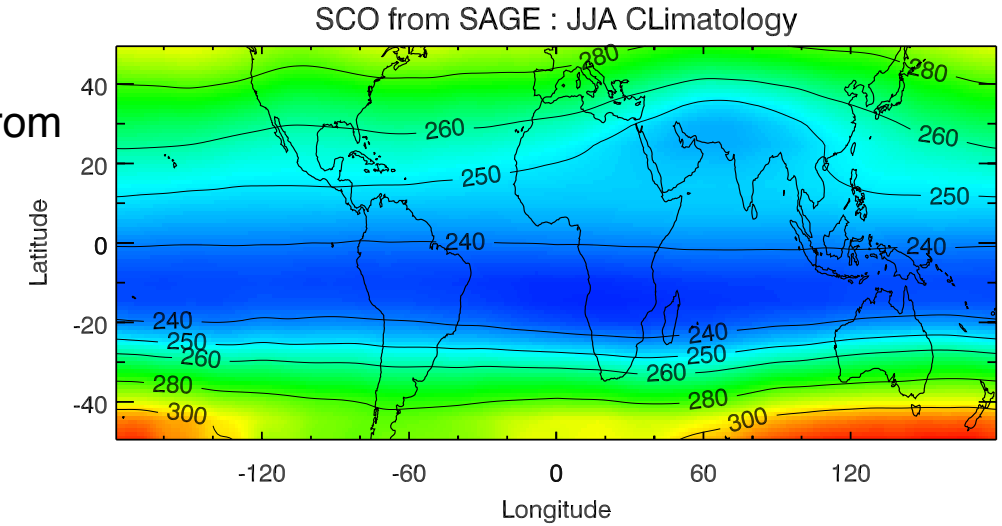
- Use OMI with Assimilation Model

# Schematic Diagram Showing How Tropospheric Ozone Residual (TOR) is Derived

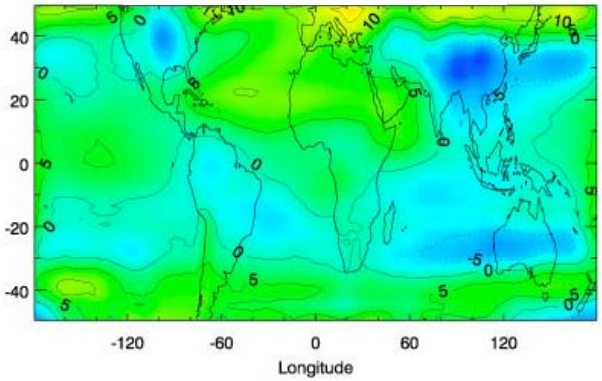


# Stratospheric Column Ozone (SCO) Derived from SBUV and SAGE Profiles in Good Agreement

Climatology from ~7000 SAGE profiles 1979-2000

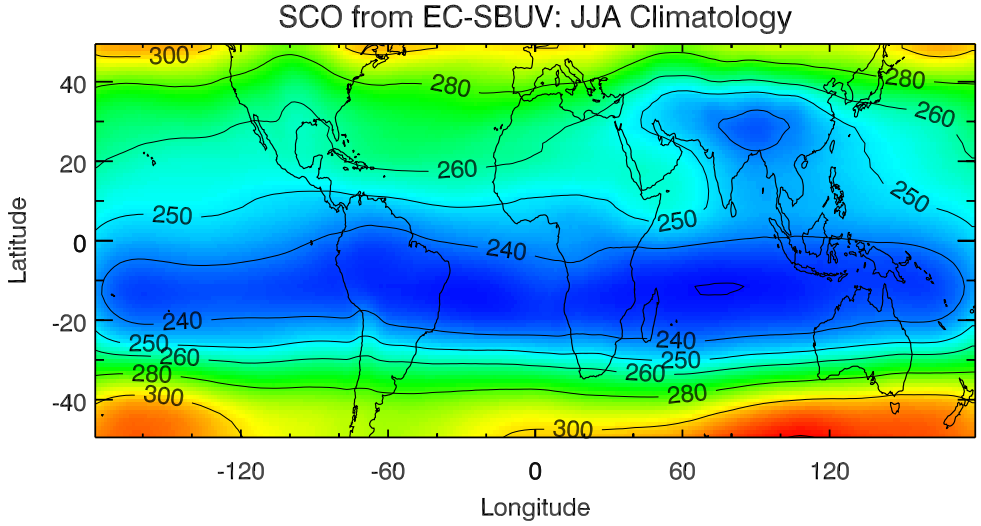



JJA Difference




Very few regions where SCO differences are >5 DU

Climatology from ~800,000 SBUV profiles 1979-2000

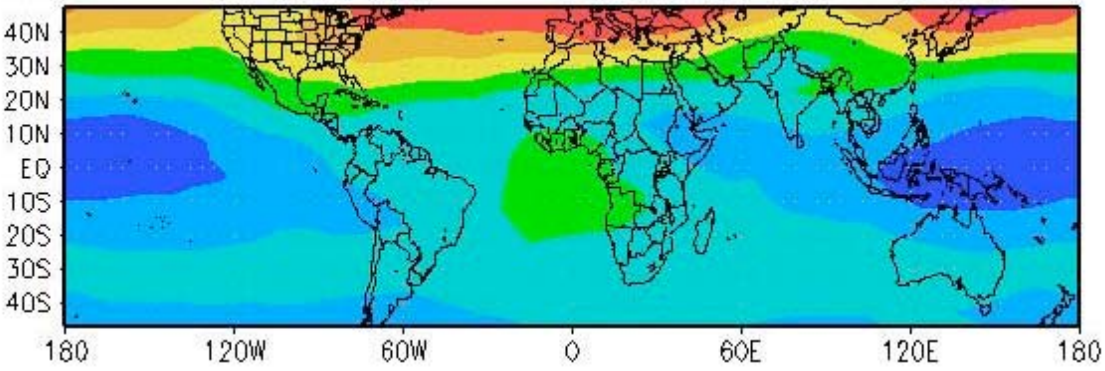



from Wozniak et al. (2005, *JGR*, **110**, D20305)

# Comparison of TOMS/SAGE TOR with TOMS/SBUV TOR:

## Regional Enhancements Identified Using More TOMS Measurements

TOMS/SAGE TOR: June-July-August Climatology

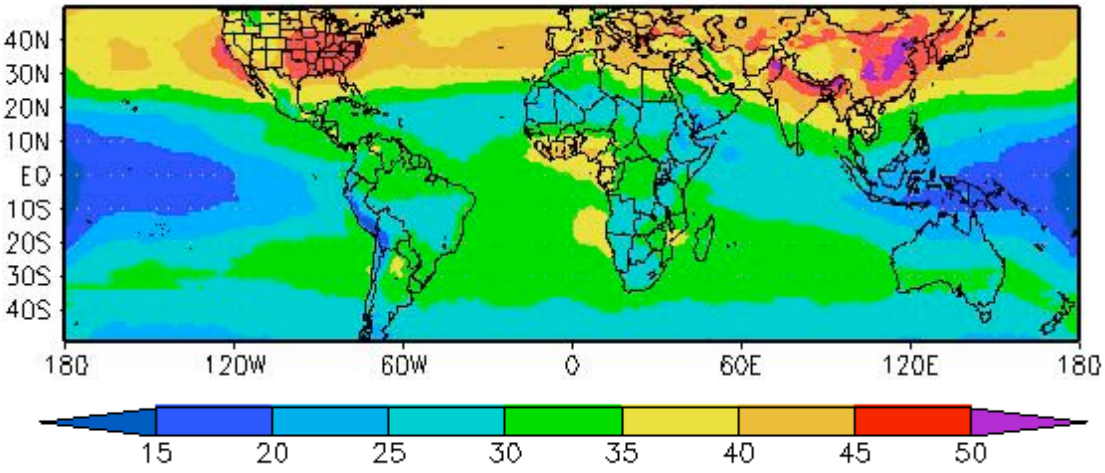



**~8000 data points**

**5° x 10° grid**

**~10 data per box**

TOMS/SBUV TOR: June-July-August Climatology




Dobson Units (DU)

**~40,000,000 data**

**1° x 1.25° grid**

**~1400 data per box**

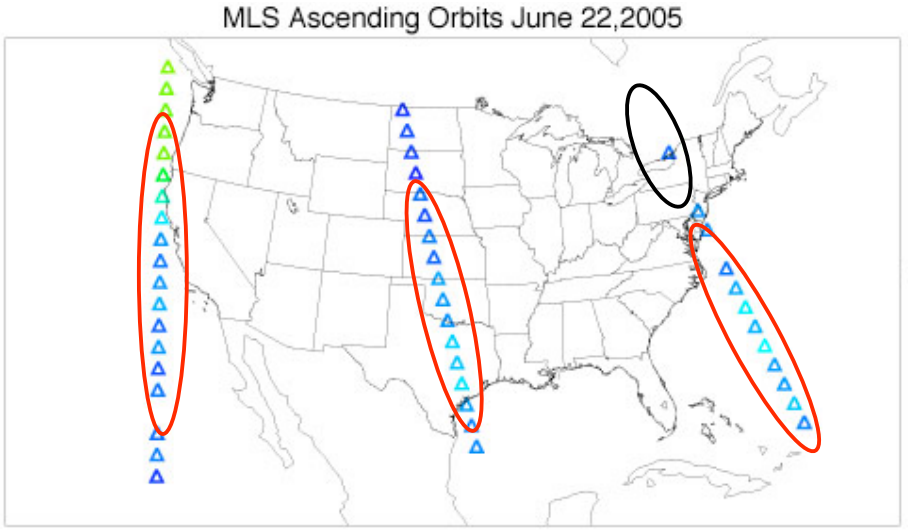
from Fishman et al. (2003)

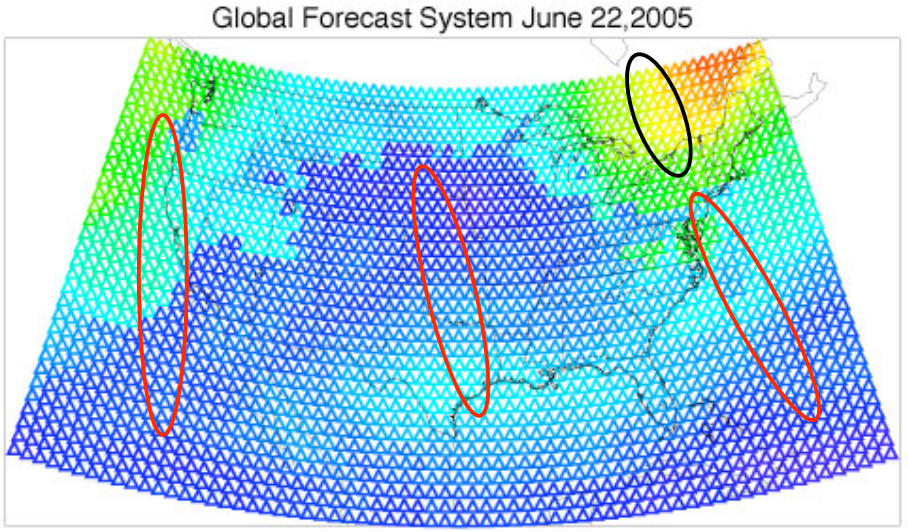
# Model-Derived SCO Provides Data Density Necessary to Construct TOR Fields from OMI Total Ozone

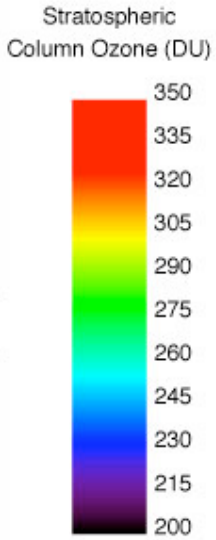
- Filling data gaps between orbits requires sophisticated interpolation

Or

- Using measurements from additional orbits before or after day of OMI measurements

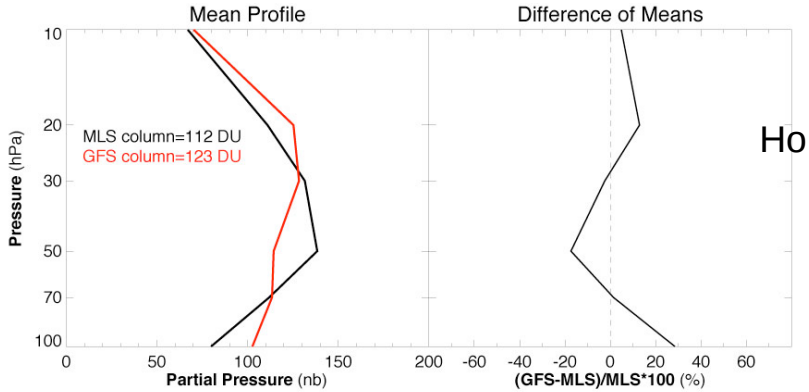


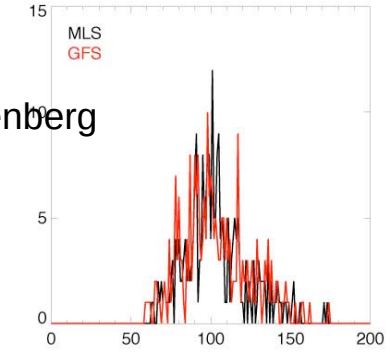



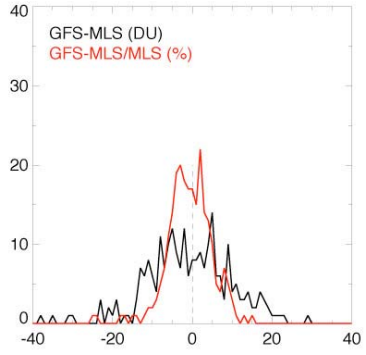

- Use of data assimilation model provides ozone fields consistent with meteorological dynamics
- Current generation of GFS model assimilates SBUV ozone
- Additional satellite data will be assimilated into GFS model

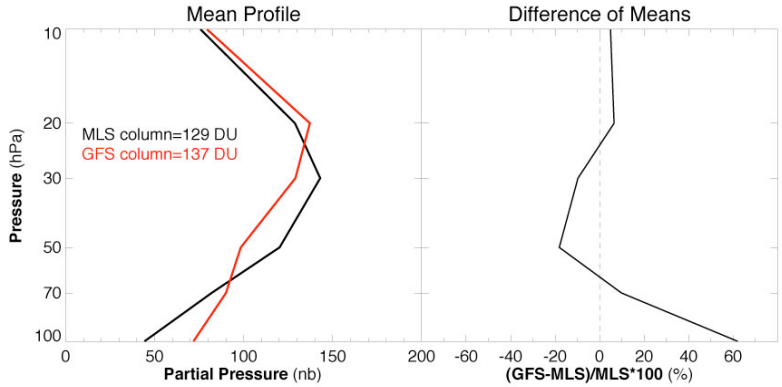
# Comparison of GFS and MLS Stratospheric $O_3$ Profiles



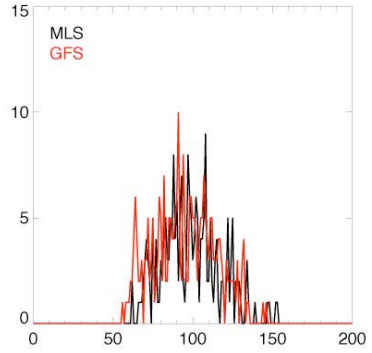

Hohenpeissenberg

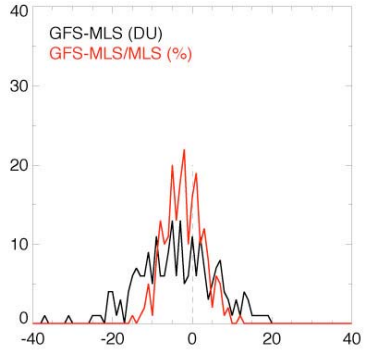


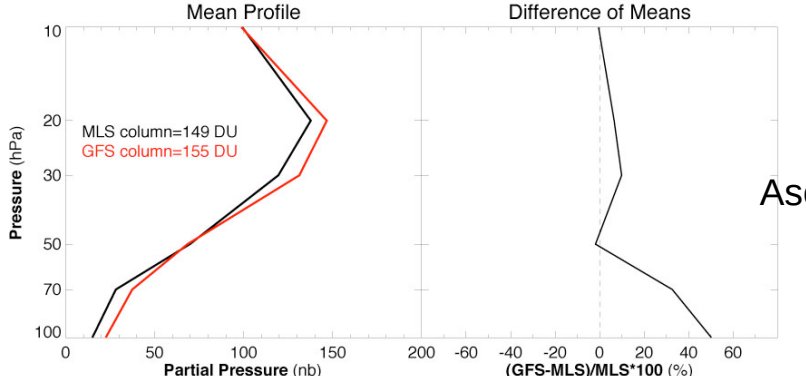



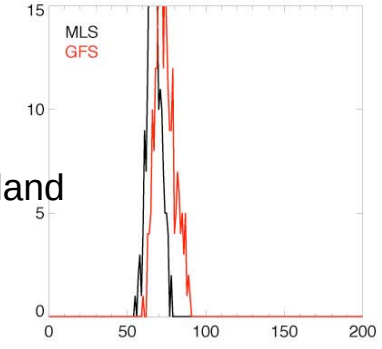

Tateno

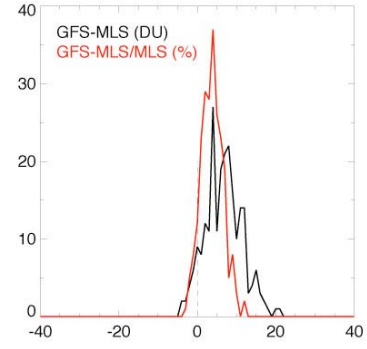



Ascension Island



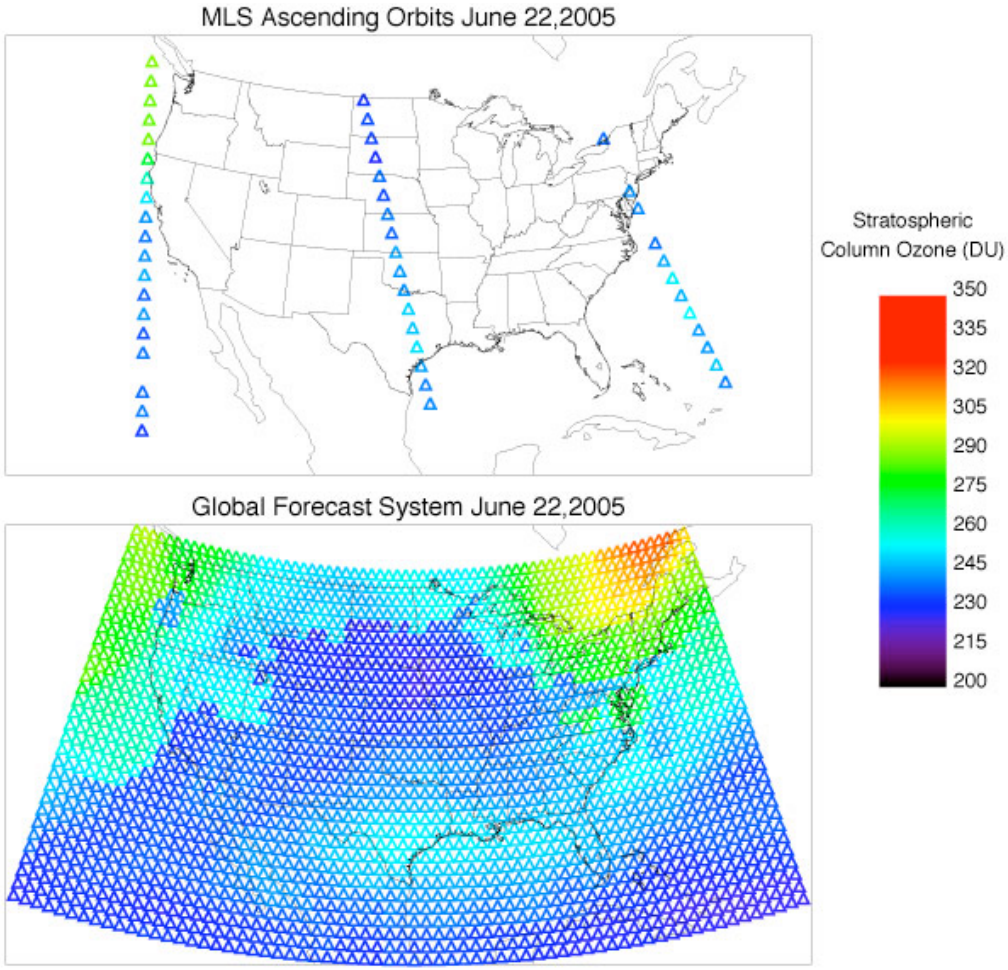



# Summary of Differences Between GFS and MLS SCO (10-100 hPa) Values

| Station | MLS | GFS | Δ(DU, %) |
|---|---|---|---|
| Ascension Island | 149 | 155 | 6 (4%) |
| Boulder | 122 | 131 | 9 (7%) |
| Hohenpeissenberg | 112 | 123 | 11 (10%) |
| American Samoa | 147 | 151 | 4 (3%) |
| Payerne | 114 | 125 | 11 (10%) |
| Tateno | 129 | 137 | 8 (6%) |
| Wallops Island | 125 | 135 | 10 (8%) |

- Finding: GFS stratospheric values consistently higher than MLS values (4-11 DU or 3-10%)
- Evaluation of MLS and GFS continuing exercise

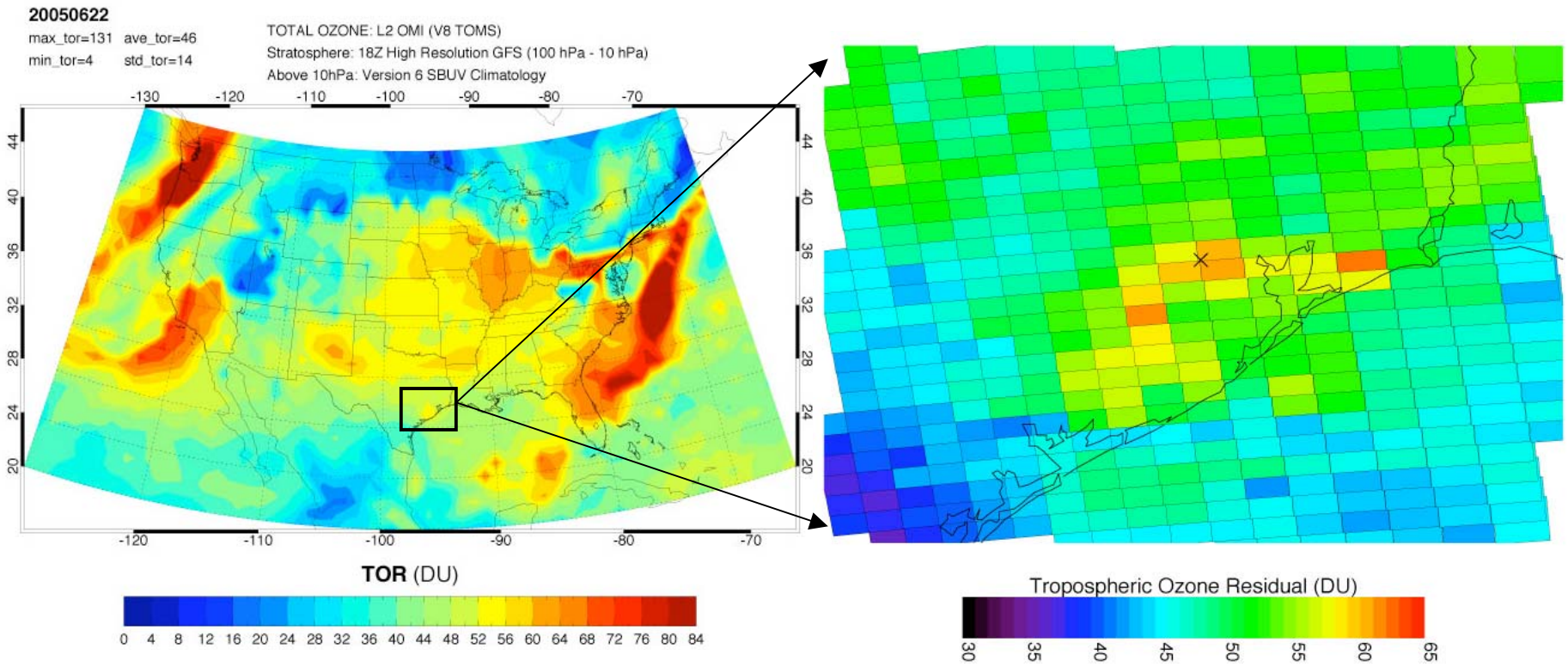
# Major Advantage of GFS is Data Density Required for Smaller Scale Studies



# Daily TOR Maps from OMI May Provide Insight into Regional Scale Tropospheric Ozone Distribution

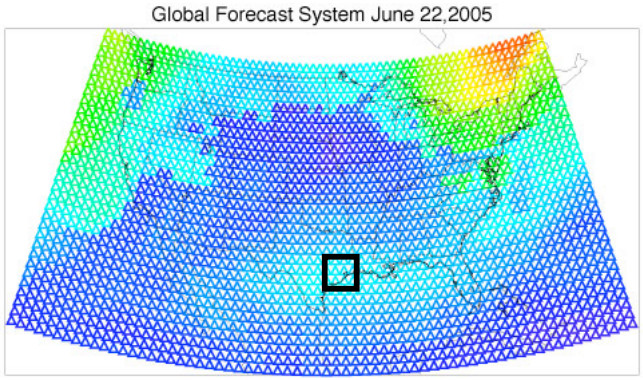
U.S. Distribution (100 km resolution)

Distribution over southeast Texas (~22 x ~30 km resolution)

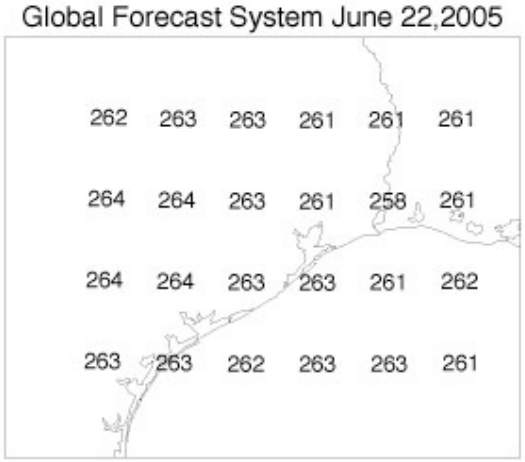


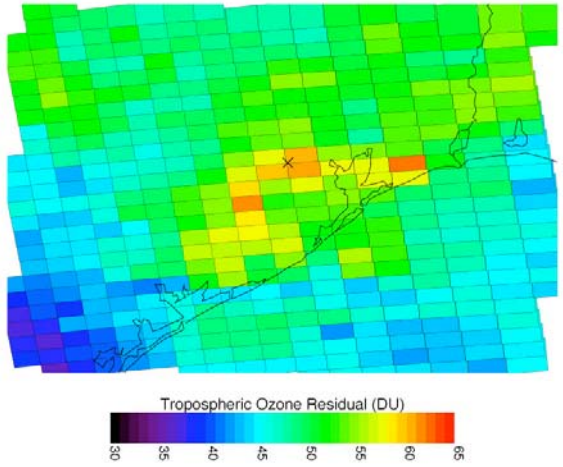

**June 22, 2005**

# Accuracy of Regional TOR Dependent on Accuracy of OMI Total Ozone




Stratospheric Gradient Minimal on Scales of Regional Interest




- Stratospheric gradient over region of interest <5 DU

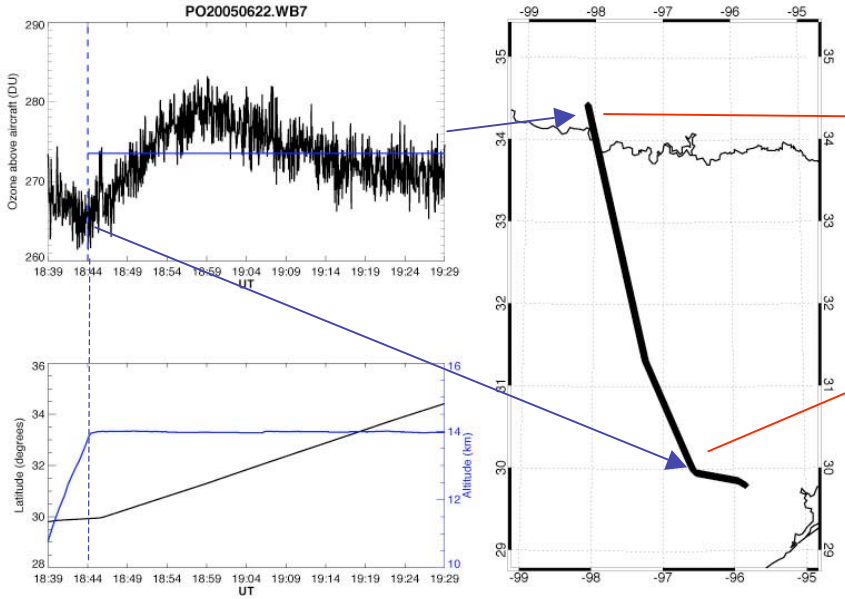
- TOR Gradient over region of interest >20 DU must come from gradient in OMI total ozone column measurements

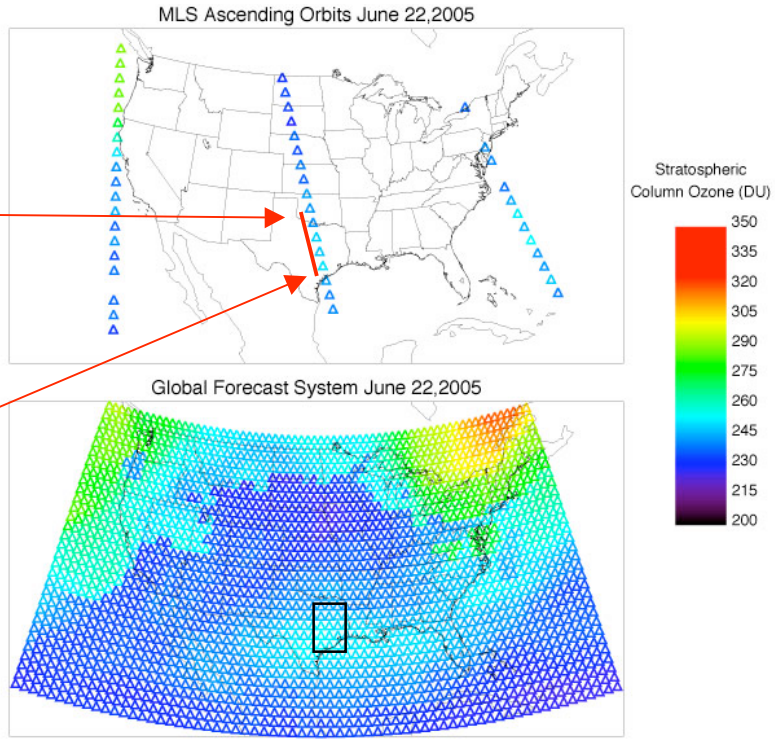
# Upward-Looking Ozone Column Measurements Confirm Small Stratospheric Gradient

**Data from CAFS* Instrument**

Integrated $O_3$ above aircraft along flight path

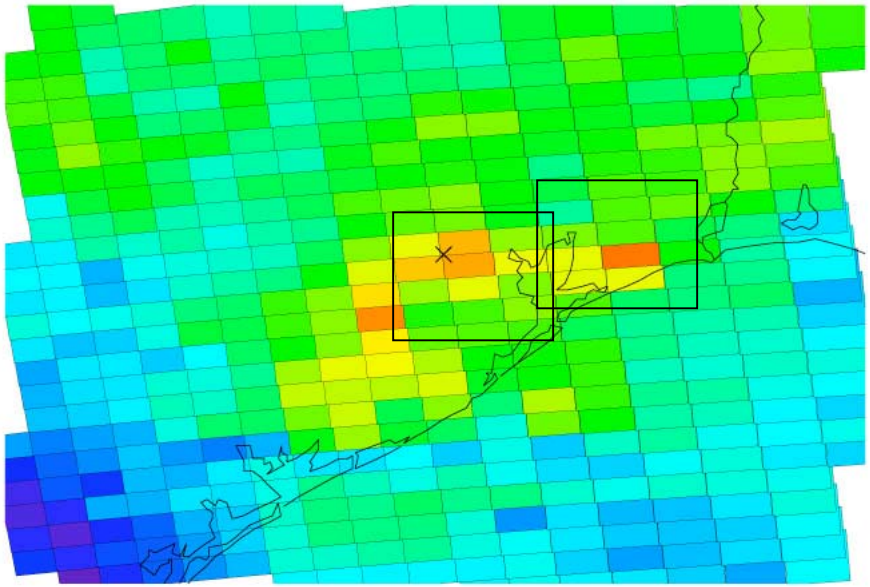
Flight path of WB-57

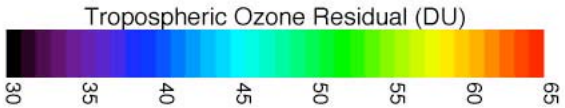


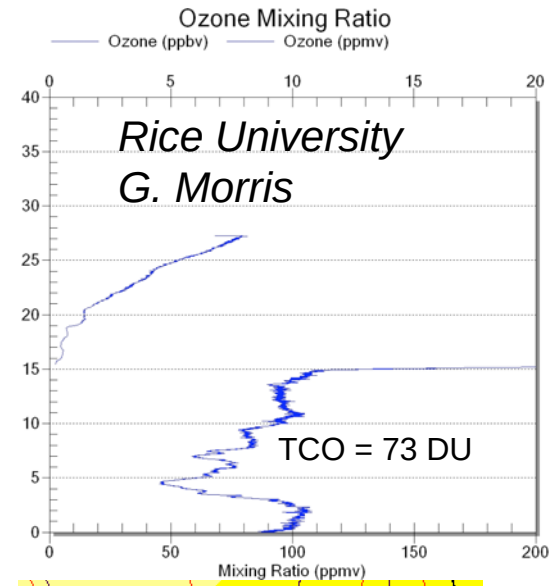




*CCD (charged-coupled device) Actinic Flux Spectroradiometer

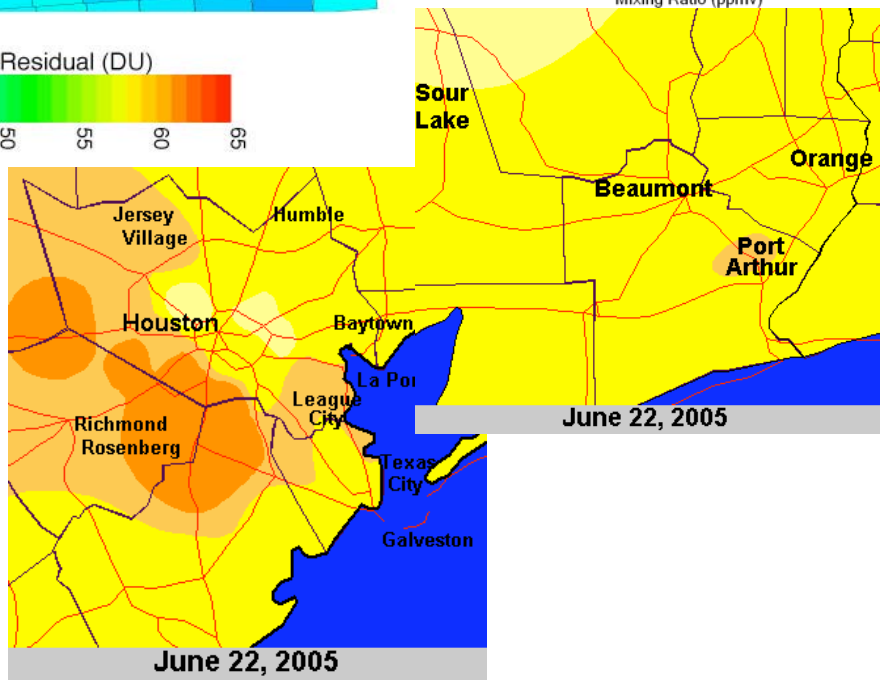
# TOR Captures Mesoscale Ozone Structure in Houston Area

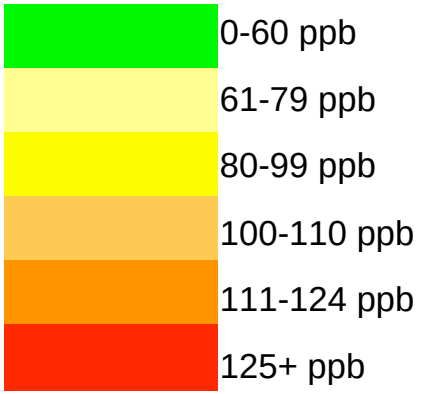





Ozonesonde confirms elevated $O_3$ in Houston on June 22, 2005



# Where Do We Go From Here?

## Next Steps:

- Continue evaluation of GFS SCO profiles
  - comparison with MLS
  - keep abreast of improvements to GFS

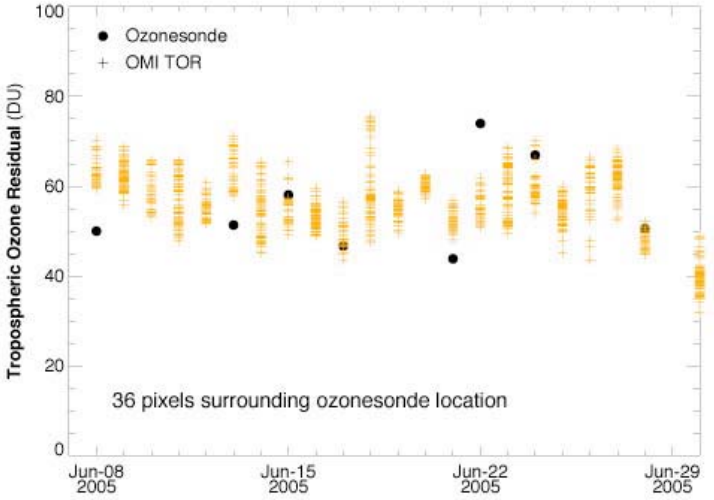
- Continue validation studies with available ozonesonde and aircraft $O_3$ data

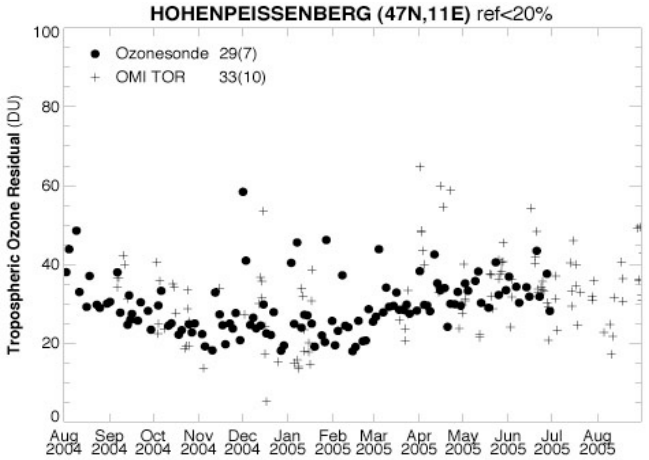
- Examine relationship between TOR patterns, synoptic conditions and surface $O_3$

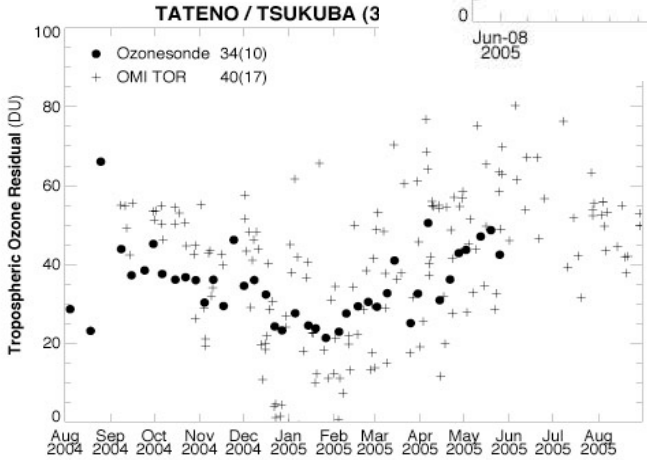
- Work with air quality forecasters to see if OMI TOR product can provide useful information
  - CMAQ runs available during Texas-2005 campaign
  - joint proposals submitted with U.S. EPA and NOAA

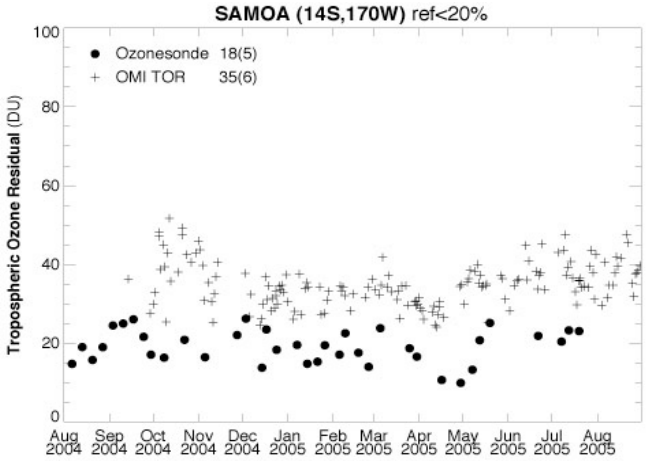
# Next Steps:

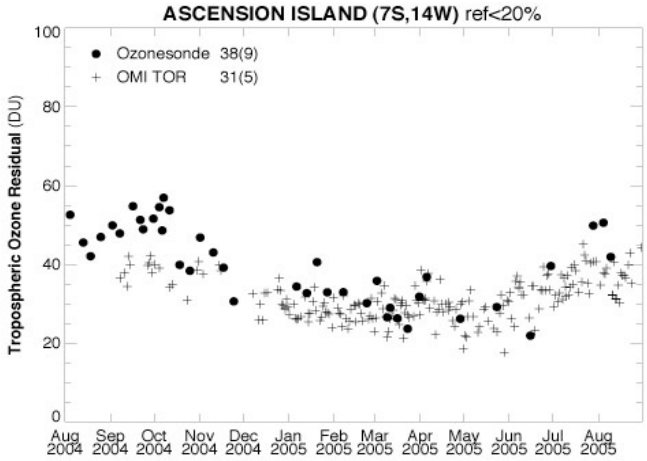
- Continue validation studies of TOR with available ozonesonde and aircraft $O_3$ data



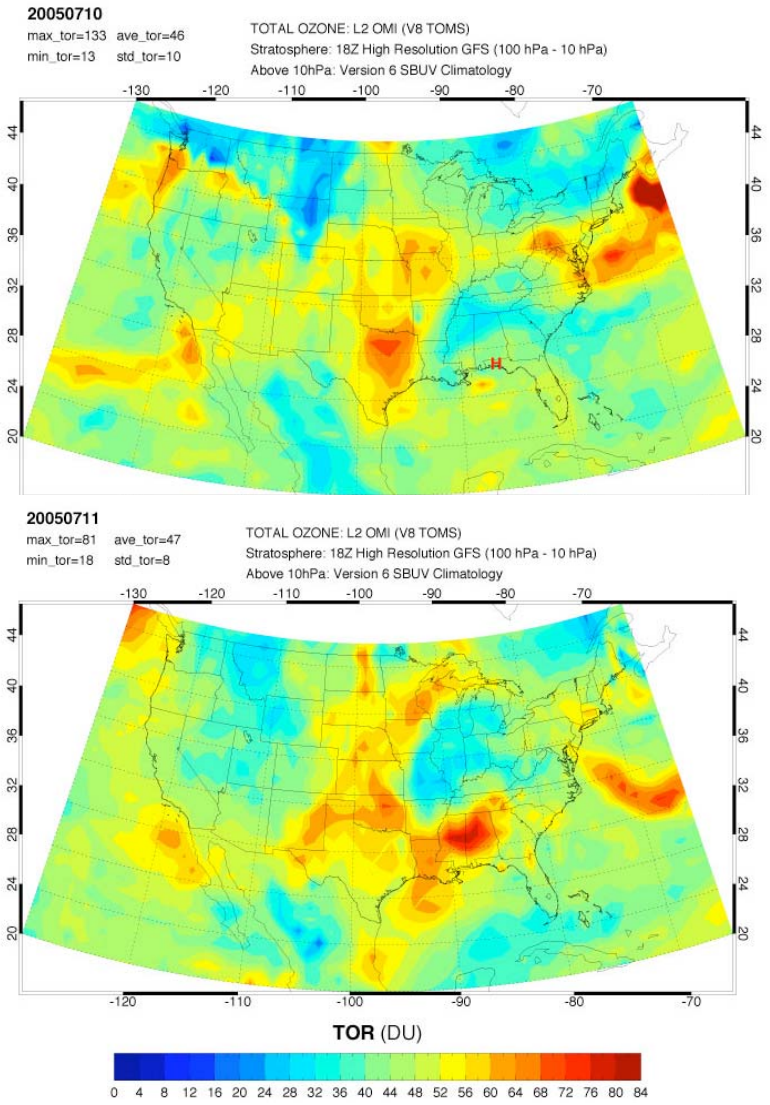



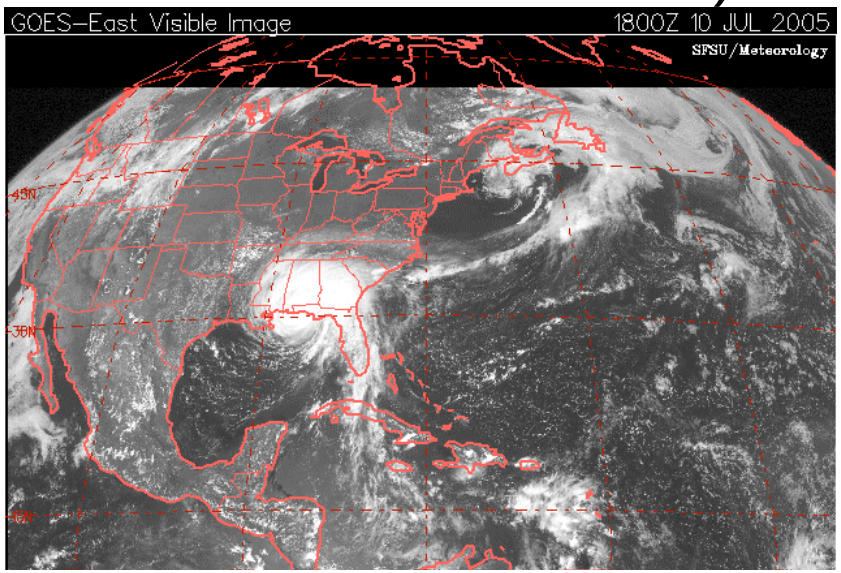



# Next Steps:

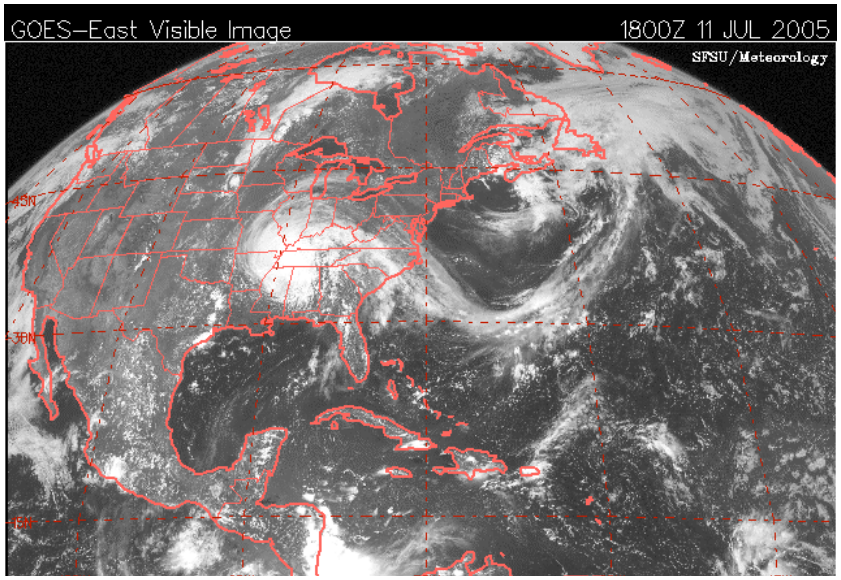
- Examine relationship between TOR patterns, synoptic conditions and surface $O_3$ (2005 active hurricane season)



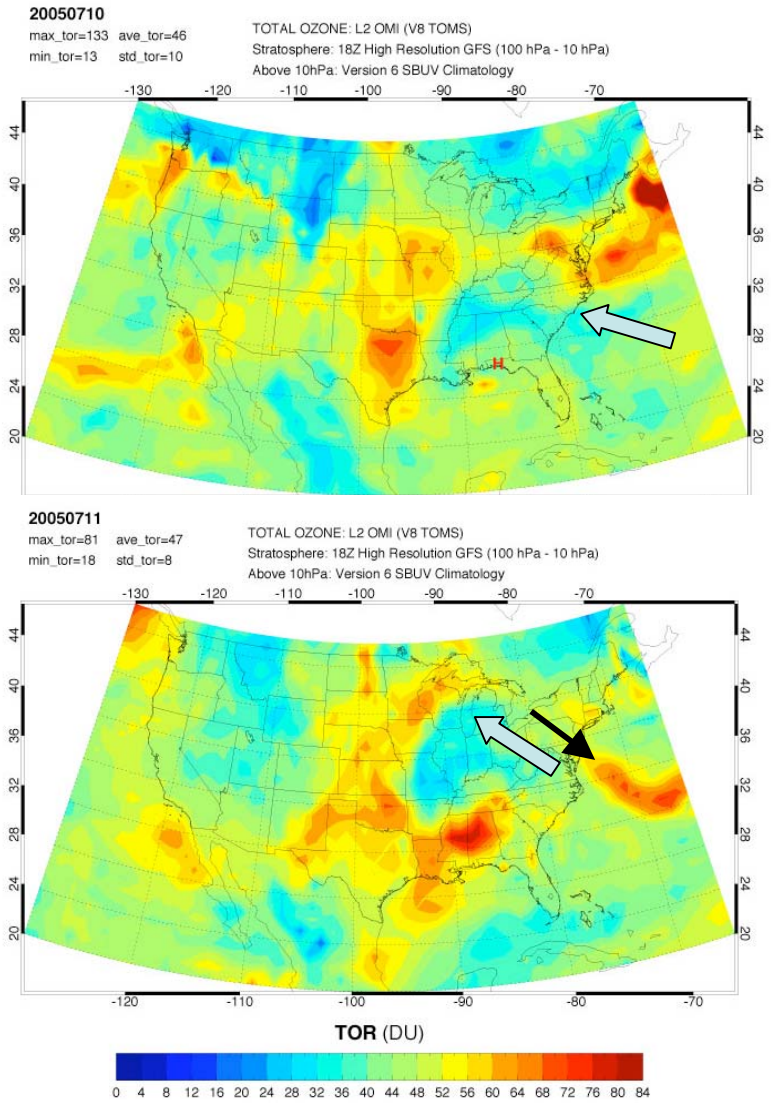

July 10



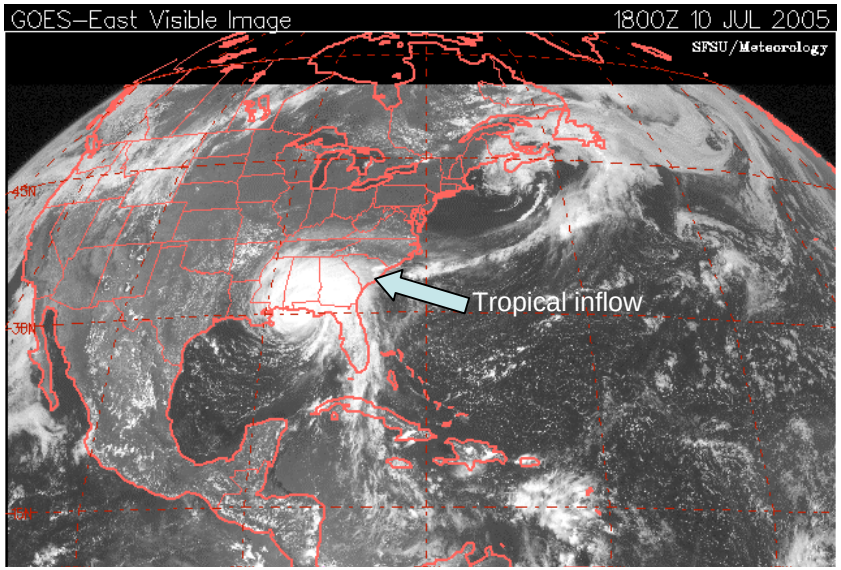

July 11



# Inflow Regions Associated with Tropical Circulation and Continental Outflow Regions in Clear Air Behind Fronts Provide Examples that Can Relate TOR to Meteorology




July 10

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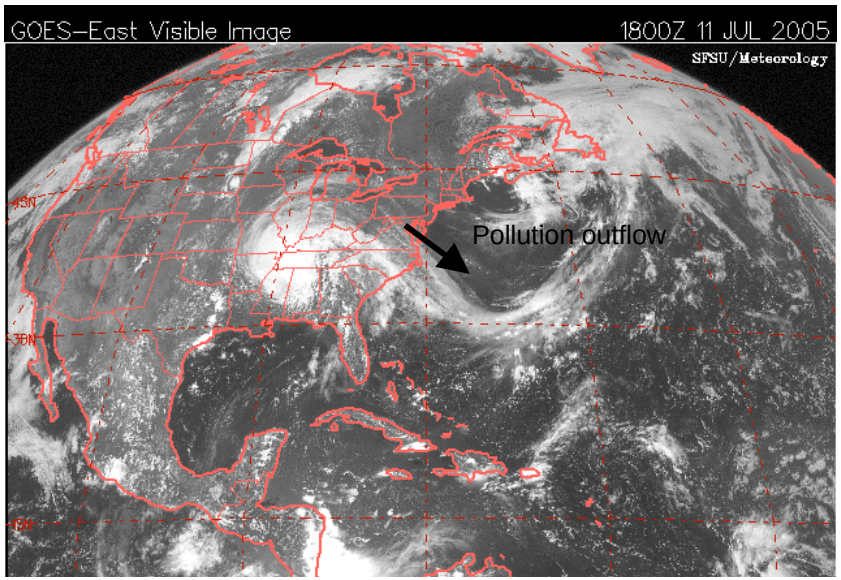
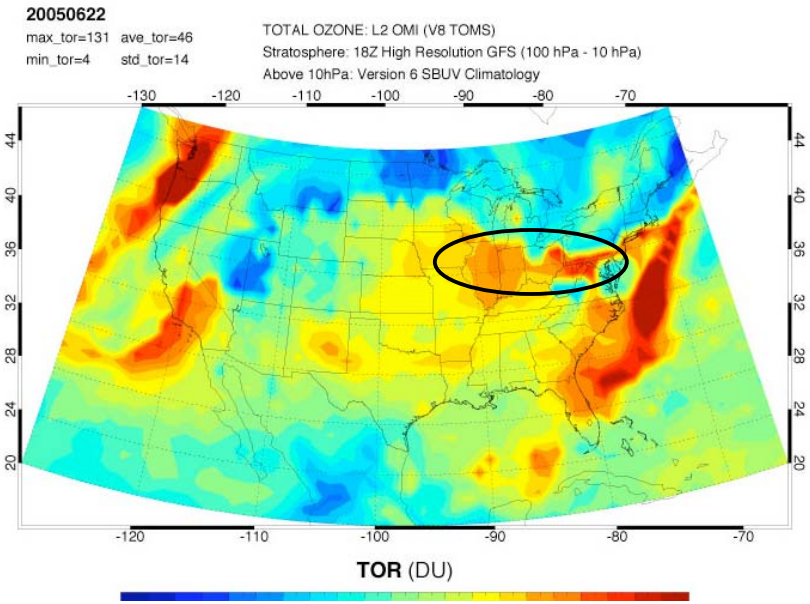
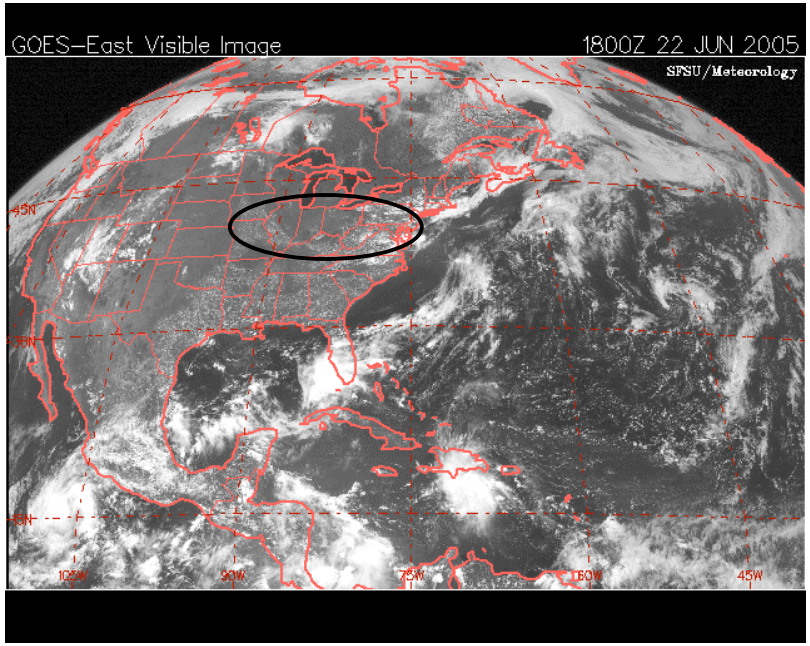
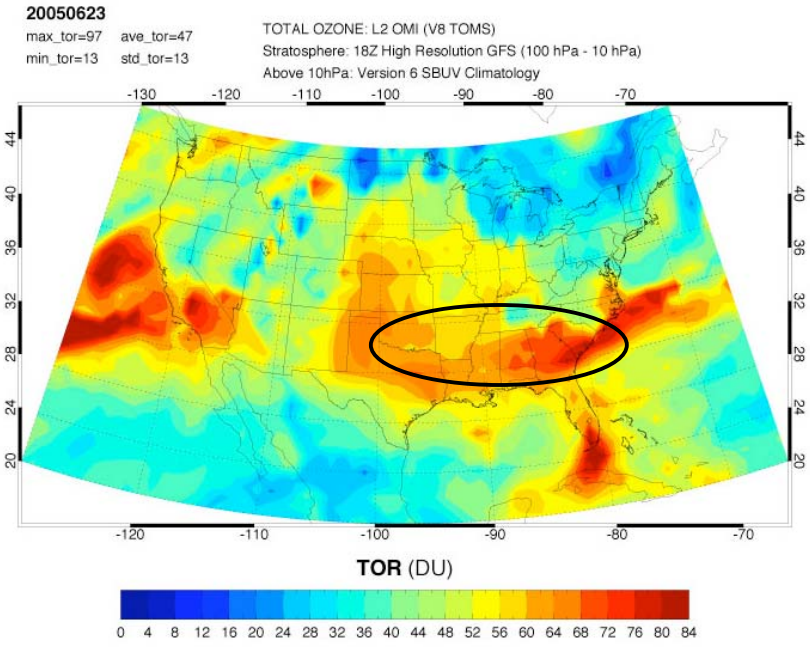


# Clear Regions over Eastern U.S. Show High TOR

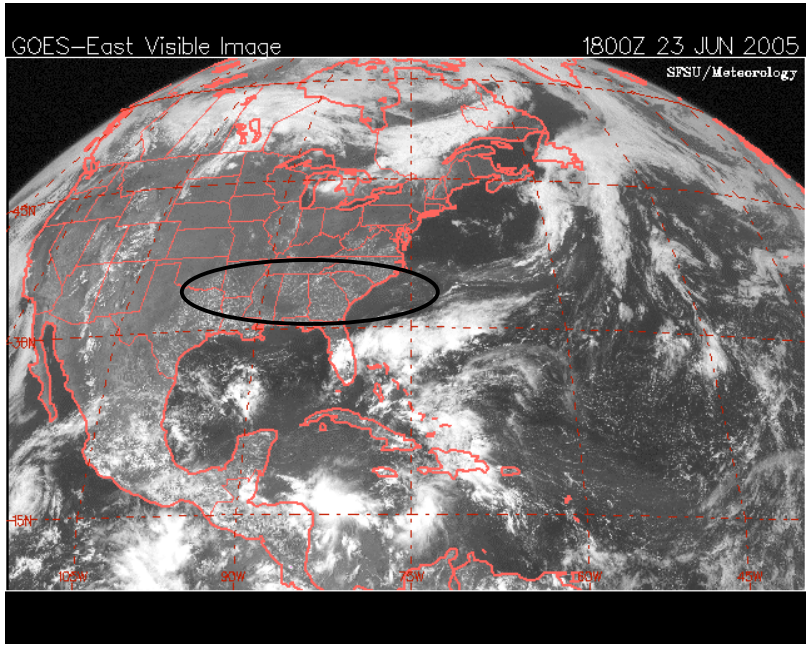



June 22



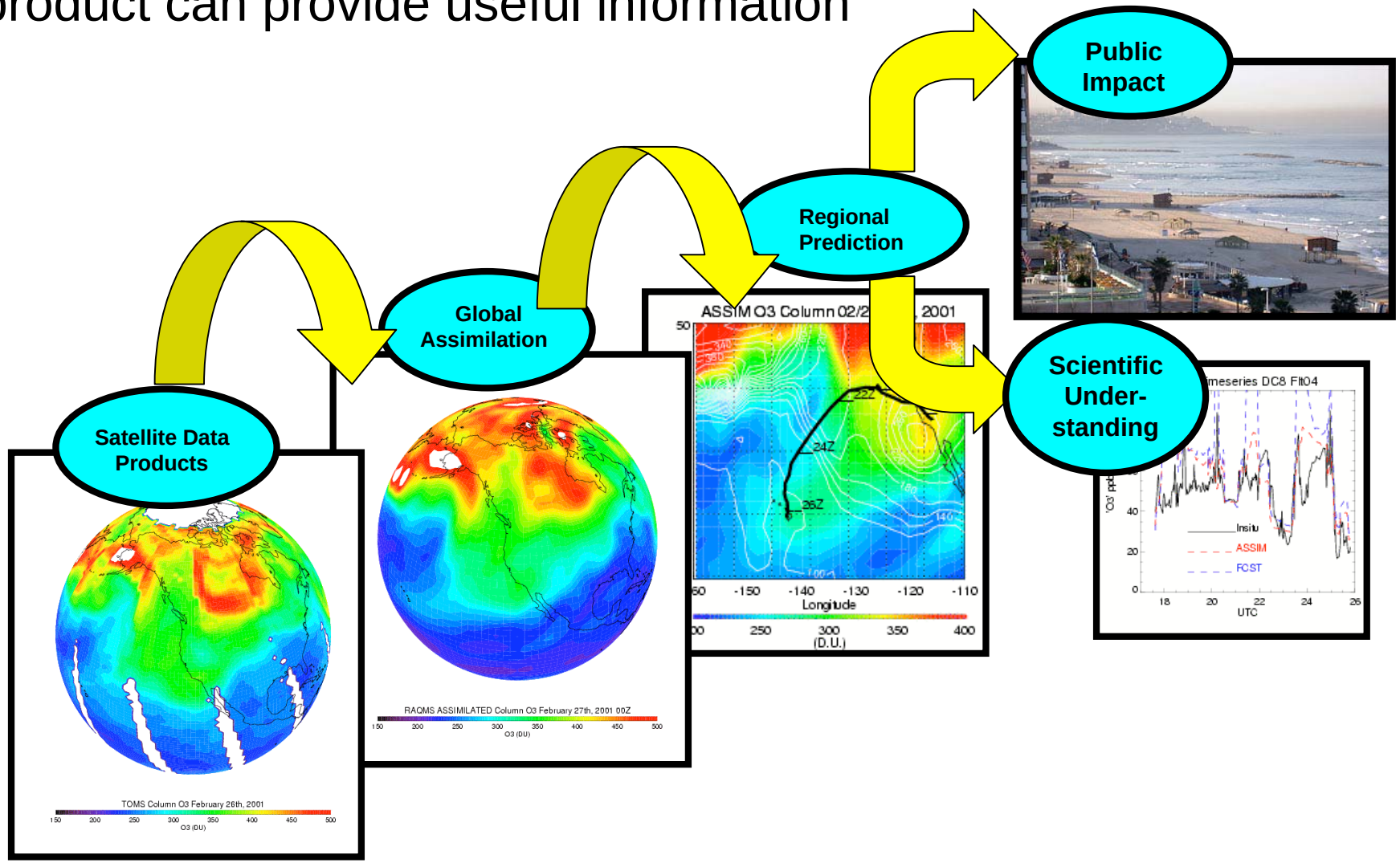




June 23



# Next Steps:

• Work with air quality forecasters to see if OMI TOR product can provide useful information



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  - CMAQ runs available during Texas-2005 campaign
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# Summary and Conclusions

- New method to derive TOR using OMI in conjunction with GFS-derived SCO fields

- Initial comparisons of GFS stratospheric $O_3$ and MLS $O_3$ profiles encouraging

- High spatial resolution TOR derived from OMI seems to be able to capture sub-regional scale pollution pattern around Houston area for a specific time
    - surface $O_3$ and aircraft measurements support TOR analysis